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(57) Abrégé/Abstract:

A process is provided in which a brewery beverage is treated with a removable solid non-ionic polystyrene adsorbent to adsorb carbonyl compounds from the beverage.



TITLE

IMPROVEMENTS IN BEVERAGE STABILITY

ABSTRACT

A process is provided in which a brewery beverage is treated with a removable solid non-ionic polystyrene adsorbent to adsorb carbonyl compounds from the beverage.

FIELD OF THE INVENTION:

The present invention relates to improved storage stability of brewery beverages resulting from the removal of certain carbonyl compounds, and in particular to flavour stability improvements in beer and ale products that follow from the treatment of corresponding brewery worts during the brewing process.

BACKGROUND OF THE INVENTION:

10 Beverages, and in particular beers (lagers and ales), are subject to changes in flavour over time. Not all such changes are desirable. Beer, for example, is known to develop objectionable stale flavours over periods of as little as a few days or months following fermentation. Although the development of these undesirable stale or "cardboard" flavours is a problem associated with all beer products, it is especially acute in ales and low-alcohol beers.

 Scientific debate over the chemistry of stale flavour development is not finally settled, although there seems to be a developing consensus that the primary offenders are unsaturated aldehydes, in
20 particular trans-2-nonenal.

 US patent 4,110,480 - Pollock associates the development of this stale flavour aldehyde, together with other long chain unsaturated aldehydes, with an enzyme-mediated oxidation of the long chain fatty acid precursors that are present in barley malt. The presence of long chain acids that are known to be oxidation products of such long chain fatty acids was confirmed by work done by Graveland et al (MBAA Technical Quarterly, Volume 9, No.2, at pages 98 et seq.), on

incubated aqueous suspensions of barley. Graveland et al went on to show that further oxidative degradation of such long chain acid intermediates could yield volatile aldehydes of the type which give rise to stale flavours in beer products. The work of Stenroos et al (MBAA Technical Quarterly, Volume 13, No. 4) confirmed the findings of Graveland et al, and went on to show that at least one hydroxy acid isomer that might be associated with subsequent oxidative formation of stale flavour aldehydes, was present in beer worts.

10 A number of solutions have been put forward in the interests of dealing with undesirable changes in a beverage's flavour profile. Each such solution has its own shortcomings.

Approaches to the above-mentioned stale flavour problem can be classified into one of two groups: 1) reactive; and, 2) proactive.

20 Pre-eminent amongst the former group of solutions has been the addition of bisulphite, which even today continues to be the commercial method of choice for dealing with the development of stale flavours in beer products. Bisulphite binds with unsaturated aldehydes that are the primary source of stale flavour in beers, to form a flavourless compound of intermediate stability. It is known that traditional beer beverages already contain bisulphite, which is present as a natural byproduct of yeast fermentation. Naturally occurring bisulphite levels are, however, generally regarded as being insufficient to stabilize beer beverages against the organoleptic manifestation of stale flavour aldehydes during the normal, commercial shelf life of these beverages. In low-alcohol beer products, the natural level of bisulphite is extremely low; so much so as to result in untreated beverages manifesting stale flavour even prior to

bottling. As a consequence of the inadequacy of the natural levels of bisulphite in forestalling the formation of stale flavour, the industry has continued the practice of adding bisulphite to beer products. US patents 1,217,641 and 1,234,255 are of historical note in connection with the adoption of this practice.

There are however a number of problems associated with this activity, not the least of which is the known depletion of bisulphite from beer beverages over time. This effect can be best visualized by following the concentration of natural levels of free sulphite ions in traditional beer beverages. Initially, such products contain natural bisulphite levels on the order of between 5 and 15 parts per million. Several weeks following fermentation, the concentration of free sulphite falls to about 2 parts per million or less. Thereafter, the concentration of free sulphite ions remains relatively constant in the short term, in a dynamic equilibrium with respective concentrations of sulphite-bound unsaturated aldehydes and free unsaturated aldehydes that are present in the finished beverage. According to work done by Nordlov et al, reported by way of a presentation made during the EBC Blackenstay Group Meeting in Oporta in May 1982, and again later in a presentation that was made to the EBC Congress in London in June 1983, at least 90% of the unsaturated aldehydes contained in beer under typical storage conditions, was present in the bound form shortly after the beverage was finished, and for so long as the relatively large excess of free sulphite remained. Although specific mechanisms are still a matter of some debate, there is an overall depletion in the concentration of sulphites present in the beer. Whatever its cause or causes, this phenomenon quickly

exhausts the above mentioned excess. As the concentration of sulphites falls still further, the dynamics of the associated chemical equilibrium favors the formation of more free aldehydes through the breakdown of the relatively unstable flavourless compounds. That process in turn manifests in an increase in stale flavour of the beverage.

10 In order to both supplement natural levels and to offset anticipated losses during the normal commercial shelf-life of these beverages, brewers often took recourse to adding fairly high levels of bisulphite, with a view to delaying stale flavour development to a time well in excess of normal shelf-life expectations. According to US patent 2,892,718, however, the "excessive amount of sulphite necessary to appreciably modify the stability, has been found to impart an off-taste to the beer, thus restricting its commercial use".

20 Alternative reactive methods were developed in order to deal with the problems associated with bisulphite addition. US patent 2,159,985 teaches the use of ascorbate as an alternative to the use of sulphites. Ascorbate is a known antioxidant and its use was intended to retard, or possibly even prevent, the production of stale flavour aldehydes through the oxidation of the long chain fatty acid and long chain acid precursors that the art associated with the formation of those aldehydes in beer products. It seems unlikely, however, that ascorbate functions as a replacement for bisulphite in forming the flavour-neutral aldehyde adducts mentioned above. Moreover, when ascorbates are added in the concentrations required to materially delay or prevent the formation of stale flavours in beer, the ascorbate itself manifests undesirably as an exogenous flavourant.

In any case it is more probable that the beneficial action of the ascorbate in stabilizing against the development of stale flavours is limited to that which is brought about through the protection of naturally indigenous bisulphite from oxidative depletion as the beverage ages over the course of its normal shelf-life. This realization underlies the teachings of US patent 2,892,718, which advocates the use of a combination of ascorbate salts and a hydrosulphite in an attempt to minimize the undesirable effects associated with the larger concentrations of each of these additives that are necessary when they are employed independently of one another. Similar approaches are represented in each of US patents 2,658,829; 3,095,358; and, 3,770,454. Each of these patents describe synergistic methods adapted to improve beer flavour stability. There are of course additional logistical, quality control and inventory related problems associated with any solution that requires more than a single additive. As a consequence to these practical commercial considerations, these synergistic methods have not been widely adopted.

Although the reactive addition of bisulphite remains the most widely employed commercial method of forestalling the onset of stale flavour formation in beer, there have been a number of unsuccessful attempts to deal with the problem from a more pro-active footing. Each of these methods deals in one way or another with attempts at removing various supposed precursors of the stale flavourants.

US patent 4,110,180, for example, advocates a process based on solvent extraction of malt, which is intended to remove what Pollock purported to be precursors of the stale flavoured aldehydes that were

ostensibly formed during the brewing process. Quite apart from any consideration of potential solvent toxicity, there is a real concern over depletion of brewhouse yields as a result of chemical denaturation of indigenous malt saccharifying enzymes. Even relatively small reductions in the brewhouse yields will have a very substantial cumulative effect on brewery economics given the large amount of malt that is used by commercial brewers and the disproportionately high cost of malt relative to the overall materials cost of the final product. Finally, the need to order, store and control the use of flammable and potentially toxic solvent materials in a potable beverage production facility poses a number of serious quality assurance and logistical problems.

The use of solid adsorbents has been attempted in the brewing arts with a view to removing the components that are believed by some to be precursors of the stale flavoured aldehydes. Stenroos et al, in MBAA Technical Quarterly, Volume 13, no. 4 (1976) disclosed a process which involved adding activated carbon to the wort and allowing it to remain there throughout fermentation, in the hope that this would remove the precursors that Stenroos et al suspected of subsequently giving rise to stale flavoured aldehydes. Stenroos et al concluded, however, that the level of activated carbon which was found to be necessary to effect any worthwhile increase in beer flavour stability was "unfortunately" also large enough to unacceptably alter the flavour and the color of the resulting beer.

This finding of Stenroos et al was entirely consistent with the an earlier known process whose intended purpose was to overtly and deliberately change the flavour, color, and generally the basic

character of the treated beverage. Reference can be made in this regard to CA Patent 340,631, which teaches that treating beer during its manufacture with even relatively small amounts of activated charcoal adsorbents could be employed in removing harsh (not stale) tastes attributed to the use of 6-row barley malts. The purpose here was to deliberately alter the taste profile of the beer, however, and the concerns expressed by Stenroos et al are actually considered to be advantageous in the context of the problem addressed by this CA patent. At the same time, the CA patent in no way addresses the issue of flavour stability.

Another example of the use of adsorbents in the treatment of beverages is disclosed in US patent 4,594,250. Here again, the primary object is to fundamentally alter the treated beverages flavour. No reference is made to any collateral improvement in flavour stability.

There is a clear and persisting prejudice in the art concerning the very limited uses to which adsorbents might be put in treating beverages.

For example, US patent 4,177,295 is primarily concerned with improvements to the beverages physical stability. Mention is made however to supposed improvements in flavour stability that the patentee has associated with the removal of polyphenols from the wort. Accordingly, the process as set out in this patent is not relevant for the present purposes, notwithstanding any improvement in other unrelated aspects of flavour stability that purportedly arise in connection with the removal of the polyphenols.

Although other patents have taught the use of a variety of

adsorbents in various other treatments intended to enhance the physical stability of beer, they too have not in any way addressed the issue of stale flavour stability that is relevant for the present purposes. The following patents, for example, are all directed to the use of adsorbents for the stated purpose of improving the physical stability of beer beverages. These processes are focussed on the proteins, polyphenols, tannins and other like compounds that are indigenous to beer, and that have been associated with turbidity and chill haze formation in beer.

10 CA patent 793,443 discloses that silica gel adsorbent can be used to remove the albumen and tannin compounds that are associated with the development of turbidity in beers.

CA patent 871,681 discloses a polyvinyl resin modified clay adsorbent useful for removing the proteinaceous complexes and tannins that are connected with chill-haze formation in beer.

CA patent 879,091 discloses a selection of acid modified laminar silicate adsorbents that are taught to be more selectively active than known bentonites in reducing the development of turbidity in beers.

20 CA patent 1,162,438 discloses a specifically substituted polyamide that is used to adsorb polyphenols from various beverages, including beer. Polyphenols are associated with chill haze development in beer, and this adsorbent is advantageous because it does not tend to adsorb desirable isohumulones.

Accordingly, prior proactive methods that utilized solid adsorbents lack commercially recognized merits that would be required to displace the continuing use of bisulphite in dealing with stale flavour development in beer. There remains, however, the matter of

growing public concern over bisulphite-related health, (especially allergy), issues.

There is considerable ongoing debate concerning the labelling of products which contain bisulphite additives. Product labeling, however, does not appear to present a real solution to the underlying problem. At best it might only go part way towards providing a cautionary reminder to an already informed segment of the consuming public. There is a general consensus amongst those who are closest to the issue, that labelling will have little practical effect in
10 dealing with the health concerns that underlay the pro-labelling lobby's initiative. Clearly, therefore, there is a real and ongoing need for new solutions to the problems that attend the addition of bisulphite to beverages in general, and to beers in particular.

SUMMARY OF THE INVENTION:

Notwithstanding any countervailing views within the scientific community, (see Graveland et al, and Stenroos et al, supra), the present inventors are now of the opinion, (based in part on data from work reported in J. Inst. Brew., November-December, 1983, Vol. 89,
20 pp.411-415), that stale flavoured aldehydes are already fully formed and present in beer worts, and that the basic problem of targeting supposed precursors is not relevant for the intended purpose of stabilizing beer against stale flavour manifestation as the product ages.

The present invention is directed to a process for the adsorption of the undesirable aldehydes from a brewery beverage, rather than being concerned with any purported precursors thereof, with a view to

leaving the balance of the wort flavour components and the subsequently produced fermentation flavour compounds largely undisturbed. Resulting products therefore tend to be more faithful to the desirable flavour standards that are traditionally associated with archetypical brewery beverages.

10 Other advantages are attributable to the practice of the present invention. In the case of the brewing of beer, for example, the removal of the stale flavoured aldehydes means that the flavour of the beverage can be expected to remain stable in at least this one respect for longer periods of time. Recall in this regard that bisulphite loses its effectiveness over time, and that the corresponding increase in the manifestation of stale flavours is a primary limitation on product shelf life. The effectiveness of the present invention, however, does not diminish over time, and thereby result in an extension of the products shelf life when compared with the limited shelf life of current bisulphite treated products. This affords the brewer with an opportunity to better schedule manufacturing over the course of the year, in spite of seasonal fluctuations in the market demand for beer beverages.

20 A logistical advantage that may also accrue, has to do with the time required to achieve equilibrium between added bisulphite and the indigenous aldehyde concentrations. Bisulphite-treated products cannot be released to market until that equilibrium is established, otherwise the still high concentrations of newly added bisulphite will produce highly objectionable sulphur flavours in the "immature" beverage. The present invention does not require an "equilibrium maturation" stage, and therefore may allow for greater throughput in

existing production facilities, since the product need not be held in intermediate storage for the time that would otherwise be required to establish that chemical equilibrium.

10 In accordance therefore, with one aspect of the present invention, there is provided a brewing process comprising the steps of contacting a brewery beverage containing preformed unsaturated aldehydes (of the type which are known to manifest undesirable stale flavours), with a removable solid non-ionic polystyrene adsorbent, to preferentially adsorb carbonyl compounds from solution. The adsorbent is employed in an amount sufficient to substantially remove the carbonyl compounds. After the wort and the adsorbent have been in contact for sufficient time to achieve this end, the two are separated to thereby also remove the adsorbed carbonyls from the wort and hence at least delay the manifestation of any associated stale flavours in the liquid.

20 If desirable flavourants are to be included in the beverage, these should be added only after the above processing steps have been completed. Accordingly, a further step associated with another aspect of the present invention entails the subsequent addition of desirable flavour components (such as hops) to the liquid. Care should be taken to avoid any concomitant addition of undesirable carbonyl species into the beverage, as will undoubtedly be apparent to the person skilled in the art in light of the teachings herein contained.

Preferably, the solid polystyrene adsorbent is selected for its ability to preferentially adsorb aldehydes and particularly the unsaturated aldehydes known to give rise to stale flavours. In light of the present invention, the selection of a suitable adsorbent,

including adsorbents which are for the present selectively adsorptive purposes, chemically equivalent to the specified polystyrene resins, will be a matter of routine experimentation. Characteristically, such resins will advantageously manifest a substantially discriminating adsorbance that is typical of the selective thresholds of the exemplary AMBERLITE (trade mark of Rohm and Haas) polystyrene resins that are disclosed in the examples which follow hereinbelow. This yields a valuable practical benefit by maintaining the essential flavour and colour profiles of the treated brewery beverage, that is not possible through the use of such non-discriminating adsorbents as activated carbon.

The present invention is useful in the treatment of brewery beverages in general, and as that term is used herein it will be understood to embrace precursors of such brewery beverages. For example, brewery beverages, herein, include such things as brewers worts, and especially those based on aqueous malt extracts. As is known in the art, such worts are themselves amenable to use as a brewery beverage in their own right, although more typically they are used as intermediates in the production of other brewery beverages. By way of an example of such intermediate uses, such worts are often fermented to produce particular beer products such as fermented ales and low-alcohol beer products in which the problem of stale flavour development is known to be especially acute.

DETAILED DESCRIPTION OF THE INVENTION:

INTRODUCTION TO THE DRAWINGS:

Appended hereto are Figures 1 through 5, which contain

drawings that are illustrative of certain aspects of the present invention. Over the course of the following detailed description, reference will be made to each of the drawings in turn:

Figure 1 is a detector response profile of a gas chromatographic analysis of carbonyl oximes that were derived from wort which had been treated using the XAD-4 resin, in the manner described in greater detail in Example 1;

10

Figure 2 of the drawings is another detector response profile, but in this case is of carbonyl oximes that were derived from a wort that had been treated with XAD-16 resin;

Figure 3 of the drawings is yet another such detector response profile, this time of the carbonyl oximes that were prepared from an untreated control sample of the wort;

Figures 4a and 4b of the drawings are detector response profiles of untreated and treated worts that are described in connection with Example 2; and,

20

Figure 5 of the drawings is a graphical representation of the comparative rates of stale flavour development in treated and untreated beers produced in accordance with Example 2.

In accordance with the preferred practice under the present invention, there is provided a process for brewing beer comprising the steps of:

preparing a malt based brewers wort;

contacting the wort with a removable solid adsorbent, (selected, as before, to preferentially adsorb carbonyl compounds from solution in said wort), in an amount sufficient to substantially remove the carbonyl compounds; and,

separating the wort from the removable solid;

10 to thereby delay manifestation of stale flavour in the beer.

The selection of suitable solid adsorbents will be apparent to the person skilled in the art, in view of the teachings herein contained. Reference is made here again to the preceding commentary on the nature of the advantages to be enjoyed by way of the substantially discriminating adsorbance associated with such non-ionic polystyrene resins as the exemplary resins that are sold under the Amberlite trade mark, (esp. the XAD 4 and XAD 16 resins that are manufactured by Rohm and Haas).

20 These resins distinguish from ion exchange resins in that the present, substantially non-ionic hydrophobic polymers derive their adsorptive properties from their macroreticular structure, a broad range of pore sizes, a very high surface area and the aromatic make-up of the adsorptive surface.

The XAD-4 resin is a polystyrene adsorbent having a dried resin 0.50 ml pore per ml of bead porosity, an 800 square meter per gram surface area, a 50 angstrom average pore diameter. Hydrated beads as

sold in the commercial form of this resin, have a skeletal density of 1.09 grams per cc, a true wet density of 1.03 to 1.04 grams per ml, and a nominal mesh size of 20 to 50. According to the manufacturer, the Amberlite XAD-4 resin is useful in the adsorption of low molecular weight water soluble organic substances from aqueous systems. Suggested applications include the adsorption of phenol from aqueous streams; the adsorption of surface active agents such as synthetic detergents, emulsifiers and wetting agents from industrial waste streams; the removal of colour producing compounds from industrial effluents, dyes from dyeing mill wastes; and, the removal of chlorinated pesticide residues from manufacturing plant effluents. Also note that the manufacturer cautions that "Amberlite polymeric adsorbents are industrial grade products and are not intended for use in analytical, medical or pharmaceutical applications without extensive purification. It is the user's responsibility to establish the required purity and obtain any appropriate government approval."

According to Rohm and Haas, the AMBERLITE XAD-16 resin complies compositionally with the United States Food and Drug Administrations FDA 21 CFR 173.65, for use in the removal of organic substances from aqueous foods, except carbonated beverages. It is used in conjunction with fruit juice decolorization and debittering, and for the recovery of anthcyans. XAD-16 is another non-ionic polystyrene resin. It is characterized by a moisture retention capacity of between 64 and 68%; a specific gravity of about 1.06. The dry resin has a minimum surface area of 750 square meters per gram, and a 0.58 to 0.63 ml pore per ml of bead porosity.

In accordance with the present invention, it has been found

that these resins, (perhaps surprisingly so in view of underlined portions of the forgoing that were paraphrased from the manufacturers product data sheets), adsorb the carbonyls referred to above, while leaving in place other desirable components which are used by yeast under oxygen limited fermentation conditions, and which are therefore important in avoiding the risk of stalled fermentations. This is to be distinguished from those earlier attempts in the art resulted in the removal of a broad range of components from the beverage, based on the belief that this was essential to the removal of precursors of stale flavoured aldehydes.

The present process is preferably carried out on a sweet wort, and preferably following the addition of any adjuncts thereto. Such an approach will enable the brewer to deal with any stale flavour aldehydes which might be added by way of the adjuncts, such as the cereal adjuncts which are often used to supplement fermentable carbohydrate levels in the wort. Moreover, treatment prior to fermentation simplifies the adsorption process, which might otherwise be adversely effected by the presence of both carbon dioxide and alcohol in fermented beer.

Treatment of the liquid with the solid adsorbent preferably follows kettle boiling of the wort. This practice has advantages pertaining to microbiological quality assurance, and is more efficacious in controlling stale flavours in the final beverage. Note in this latter regard that furfural is a saturated aldehyde that also is associated with stale flavour in beers. Furfural is known to be produced by thermal degradation of carbohydrates and amino acids during kettle boiling of beer worts. Other undesirable carbonyl

components are also known to be produced as a result of thermal degradation of amino acids during the kettle boil. The use of selected adsorbents in accordance with the teachings of the present invention can be effective in adsorbing these undesirable carbonyls as well.

Note, however, that the use of adsorbents following kettle boiling, may reduce the concentrations of certain compounds that are contributed by the addition of hops. Hop addition is traditionally carried out in the kettle, and prior to boiling of the wort. In order to deal with this situation, it is preferred that hopped beverages that are prepared in accordance with the present invention be hopped through the addition of isomerized hop extracts and hop oils following fermentation, in order either to supplement the hop levels, or to provide the sole source of hop components in the beverage.

Example 1:

One stainless steel column (one inch in diameter and eighteen inches long) was packed to a depth of eighteen inches with XAD-4 adsorptive resin. A substantially identical column was prepared with XAD-16 resin. The packed columns were equilibrated with a pair of successive two hundred milliliter washes of deionized water.

Twenty successive bed volume equivalents of sweet wort were passed through each of the above mentioned columns, at flow rates of 10 milliliters per minute.

Treated worts were separately collected and analyzed.

While some lag occurred which effected the passage of wort carbohydrates through the columns (most so in the case of XAD-4

Resin), there was no significant reduction in yield.

For spectral analysis purposes, oxime derivatives were produced from each of the worts under study. Two hundred milliliter samples of each wort were shaken in a separatory funnel with three successive one hundred milliliter washes of diethyl ether. The immiscible mixture was shaken to extract ether soluble organics from the wort, and in each case the three volumes of ether were then combined with one another to produce an ether extract solution of about three hundred milliliters. An aqueous solution containing sodium acetate and hydroxylamine hydrochloride was added to the ether extracts, and the resulting mixture was stirred under ether refluxing conditions for about two hours in a forty degree centigrade
10 water bath. The ether layer was separated, and washed with an eight percent sodium bicarbonate solution, then dried using sodium sulphate. The dried ether solution was then concentrated to four milliliters in a Kuderna-Danish apparatus, and then further concentrated to one hundred microliters in a five milliliter sample vial under a twenty degree centigrade nitrogen stream. The resulting samples contained the aldehyde oxime derivatives necessary for subsequent gas chromatographic analysis.

The analysis was carried out on a Hewlett-Packard HP 5992 (trade-marks of Hewlett-Packard) gas chromatograph that was directly interfaced with a VG-12-250 quadrupole mass spectrometer.

Gas chromatographic analysis of these aldehyde oximes revealed, (see Figures 1 and 2),
20 that both XAD-4 and XAD-16 treated worts lacked most of the high molecular weight aldehydes that could be identified in the control (untreated) wort, (see Figure 3). The use of the XAD-

16 resin is clearly the treatment of choice, however, owing to the greater proportional reduction in carbonyl, and especially aldehyde concentrations in the XAD-16 treated wort, as compared with the concentrations of the same chemical species in the XAD-4 treated wort, (compare Figures 1 and 2).

Example 2:

Wort was conventionally prepared for use in flavour stability studies relating to the practice of the process of the present invention.

A glass column 2.75 inches in diameter and 30 inches in length, was packed to a depth of 18 inches with XAD-16 resin. The resin was washed and equilibrated with two 1 litre aliquots of deionized water.

A disc of stainless steel mesh was placed atop the resin in the column in order to collect any trub that might be suspended in the wort. Flow rates of the wort through the resin were gravity dependent. Two thirty litre samples of cooler wort were then passed, one after the other, through the adsorbent resin in the column. The first of the two thirty litre samples cleared the column in about 90 minutes, while the second thirty liters required about 105 minutes. The difference in flow rates was attributed to trub fines that had passed through the stainless steel mesh and whose cumulative effect was to obstruct the flow of the wort through the resin.

Oxime derivatives prepared from the latter of the two treated wort samples and from the control wort sample were subjected to gas chromatographic analysis. Figures 4a and 4b of the drawings illustrate the respective profiles of the derivatives prepared from

untreated and treated worts, respectively. The results clearly show that the great majority of the carbonyls were removed from the wort that had been treated with the XAD-16 resin, as compared with the control wort. Preferably, the present process results in the removal of 80 to 90%, or more of such carbonyls. The results of the trials exemplified herein evidenced removal rates of about 95%.

The two treated wort samples and a control wort were then fermented and otherwise normally processed in a pilot plant facility.

Aldehydes that were present in the control beer, but which were
10 not present in the treated beers include: butanal; hexanal; 2-methyl-2-pentenal; benzaldehyde; phenylacetaldehyde; diacetyl; and various isomers and long chain (eg eighteen carbon) saturated and unsaturated aldehydes.

Further analysis of the finished beer products focused on oligosaccharide and pentose sugars; amino acids; and, acidity, sulphite, bitterness, aeration, copper and iron, color, and overall protein content. In addition, the finished beer products were subjected to taste panel evaluations, in order to assess the sensory impact of the treatments that had been carried out in accordance with
20 the present invention. Samples of each of the beers were stored under both forced and warm storage conditions to accelerate the manifestation of stale flavours.

The results of the analysis confirmed that the present resin treatment does not significantly alter sugar, protein or amino acid or alcohol levels in the finished products. Minor reductions in the color of the treated product did result, but are both insignificant and in any case correctable through post-fermentation addition of

colorants.

At the same time, the treated products of the present invention did not manifest any significant amount of stale flavour development over a 15 month test period, while the control beer developed stale flavours in the normal manner. Figure 5 of the drawings is a graphical representation of the relative increase in the manifestation of stale flavour of both treated and untreated beers over the 15 month test period.

10 Note also that the fact that the copper and iron levels were unchanged as a consequence of the present treatment, is of considerable significance, and not because those levels are of themselves necessarily desirable. The significance arises because the corresponding level of metal-catalyzed oxidation reactions in both treated and control beer products are therefore the same, notwithstanding the treatment associated with the present invention. This finding is consistent with the view that the preformed carbonyls which are present in the wort are responsible for most of the manifestation of stale flavours in beer, which in turn makes it possible for the present invention to be efficacious in improving
20 stale flavour stability of the final products without the need for the removal of the so-called precursors that were targeted by prior art processes.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A brewing process for producing a brewery beverage comprising the steps of:

contacting a brewery beverage containing preformed unsaturated aldehydes which manifest as undesirable stale flavours in said beverage, with a removable solid non-ionic polystyrene adsorbent, to preferentially adsorb carbonyl compounds from solution in said beverage, in an amount sufficient to substantially remove said carbonyl compounds; and,

separating said beverage from said removable adsorbent;

to thereby delay the manifestation of said stale flavours in said beverage.
2. The process according to claim 1 wherein said solid preferentially adsorb aldehydes.
3. The process according to claim 2 wherein said solid preferentially adsorbs unsaturated aldehydes.
4. The process according to claim 3 wherein said brewery beverage is a brewers wort comprising an aqueous malt extract.
5. The process according to claim 3 wherein said brewery beverage

is a beer selected from one of the group consisting of ales; and, low alcohol beers.

6. The process according to claim 1, wherein said brewery beverage is a sweet brewers wort.
7. The process according to claim 6 wherein said wort is contacted with said solid following the introduction of any cereal adjuncts to the wort.
8. The process according to claim 7 wherein said wort is contacted with said solid following kettle boiling of said wort.
9. The process according to claim 8 wherein hops are not added during said kettle boiling.
10. The process according to claim 9 further including the step of subsequently adding hop extracts to said wort.
11. The process according to claim 1 wherein said brewery beverage is filtered prior to contact with said solid.
12. The process according to claim 8 wherein said wort is contacted with said solid prior to fermentation.
13. The process according to claim 1 wherein 80% or more of the detectable carbonyls in said brewery beverage, are adsorbed on said

solid.

14. The process according to claim 1 wherein said solid adsorbs 90% or more of the detectable carbonyls in said brewery beverage.

15. The process according to claim 12 wherein at least about 95% of said detectable carbonyls are removed from said brewery beverage.

BERNARD BEASLEY

PATENT AGENT

FOR THE APPLICANT

FIG.1.

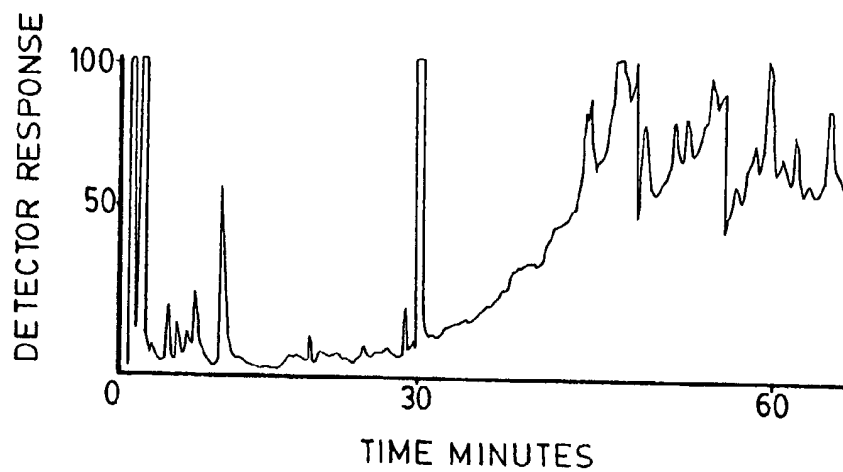
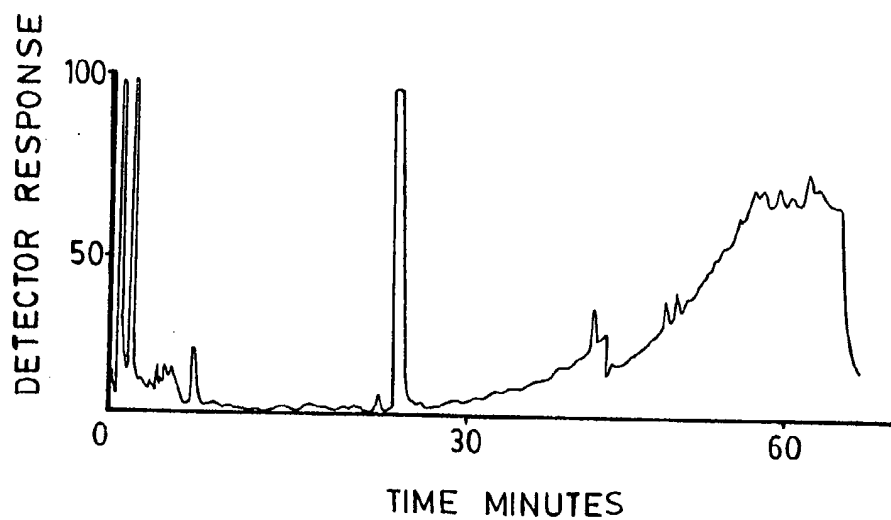


FIG.2.



Bernard Beasley

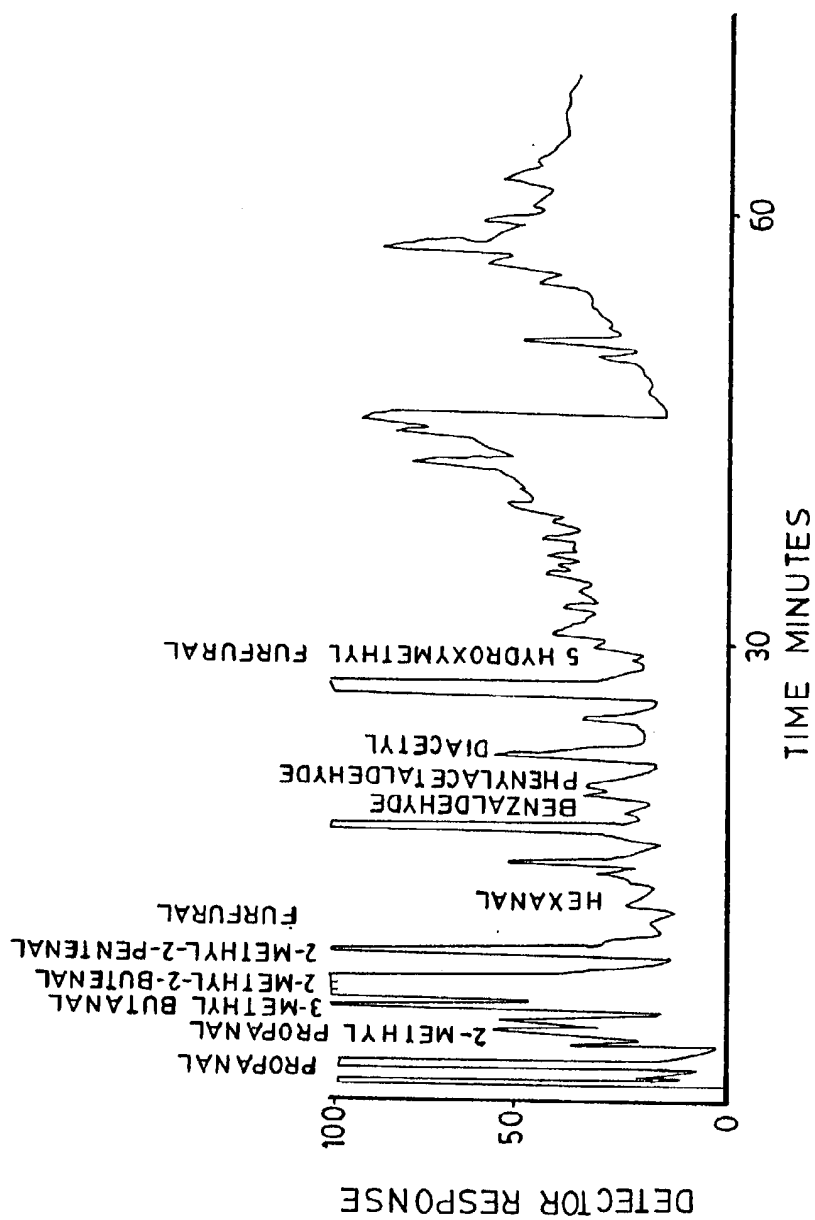


FIG.3.

Low Back

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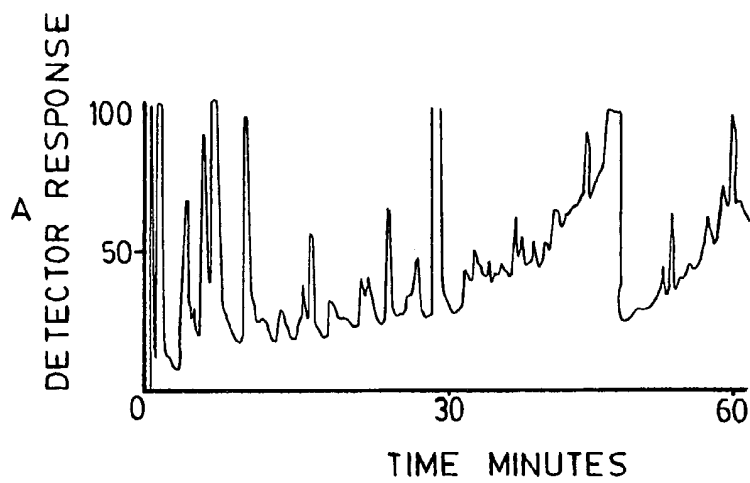


FIG.4a.

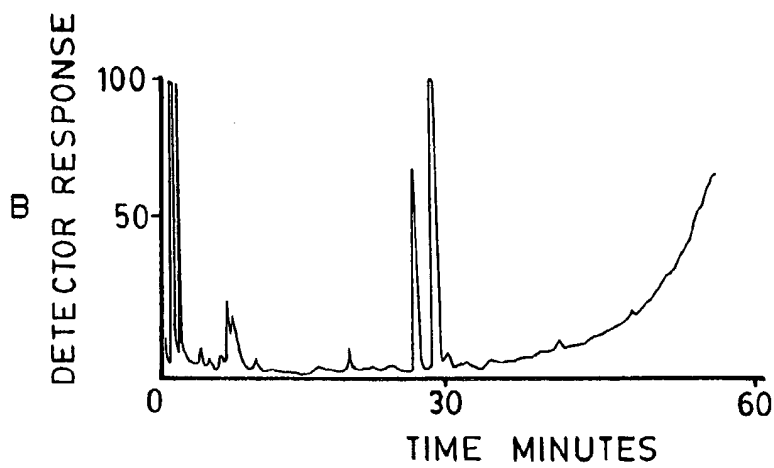


FIG.4b.

Barry Beatty

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Review

FIG. 5

